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TO:	Rex Scare, Chair TC 6.1, <u>rexs@armstronginternational.com</u> Thomas Cappellin, Research Subcommittee Chair TC 6.1, <u>tcappellin@msn.com</u> Harvey Sachs, Research Liaison 6.0, <u>hsachs@aceee.org</u>
FROM:	Michael Vaughn, MORTS, <u>mvaughn@ashrae.org</u>
DATE:	November 13, 2015
SUBJECT:	Research Topic Acceptance Request (1736-RTAR), "A novel approach for modeling of hydronic systems in Building Performance Simulation (BPS) tools

During their fall meeting, the Research Administration Committee (RAC) reviewed the subject Research Topic Acceptance Request (RTAR) and voted 4-0-0 to <u>reject</u> it. The following list summarizes the consensus review comments and questions on this RTAR:

- 1. Coordinate with other TC's, especially TC 1.4 and TC 4.7 as suggested earlier by RAC.
- 2. The research as proposed in the revised RTAR still appears to be of limited value to ASHRAE Suggest research be refocused on model validation and /or on how to better integrate existing tools.
- 3. RTAR explanation of the problem of simulating targeted hydronic system is insufficient. Is the major problem lack of information on the flow features with control valves?
- 4. Background review is incomplete (ignores 825-RP, which provided models for TRNSYS, which had numerical problems, and HVACSIM+, which worked well, though is noted in passing in Relevance and Benefits) and is out of date (ignores recent work based on Modelica, which largely addresses the model development objectives of the RTAR Modelica system models can be linked to Energy Plus and will form the basis of the HVAC modeling in a major new version of Energy Plus currently under development. However, there is still an important need for verification/validation this would be a better focus for the RTAR.
- 5. Simulation methods and tools are now available and model development has progressed to the point where the limitations of existing models need to be determined empirically.

By rejecting this RTAR, RAC is strongly suggesting to the TC that this particular topic be dropped from the TC research plan based on the information that has been provided.

An RTAR evaluation sheet is attached as additional information and it provides a breakdown of comments and questions from individual RAC members based on specific review criteria. This should give you an idea of how your RTAR is being interpreted and understood by others.

If the TC wishes to pursue this topic further, please incorporate the above information into the RTAR with the help of your Research Liaison, Harvey Sachs <u>RL6@ashrae.net</u>, prior to submitting it to the Manager of Research and Technical Services for further consideration by RAC. In addition, a separate document providing a point by point response to each of these comments and questions must be submitted with the RTAR. The response to each item should explain how the RTAR has been revised to address the comment, or a justification for why the Technical Committee feels a revision is unnecessary or inappropriate. The RTAR and response to these comments and questions must be approved by the Research Liaison prior to submitting it to RAC.

The next realistic submission deadline for RTARs and WSs is **May 15, 2016** for consideration at the Society's 2016 annual meeting. The submission deadline after that is **August 15, 2016** for the RAC fall meeting.

Project ID	1736		
Project Title	A Novel App	oach for Modeling of Hydronic Systems in Building Performance Simulation (BPS) tools	
Sponsoring TC	TC 6 1 (Hudro	anic and Steam Equipment and Sustems)	
Cost / Duration	\$150,000 / 12	M M	
Submission History	2nd Submiss	ion, 1st Submission Jul.2014	
Classification: Research or Technology Transfer	Technology T	ransfer	
RAC 2015 Fall Meeting Review			
Essential Criteria	Voted NO	Comments & Suggestions	
Background: The RTAR should describe current state of the art with some level of literature review that documents the importance/magnitude of a problem. References should be provided. If not, then note it in your comments.	13, 9	13 - Tools exist for modeling piping although these are not integrated into energy modeling tools. Perhaps the focus of project should be on how to better integrate existing tools, not development of a new tool. 9 - Explanation of the problems of simulating targeted hydronic system is still insufficient. Are the major problems lack of information on the flow features with control valves? Cannot any independent flow network model be coupled with such energy simulation models? 11- Background review is incomplete (ignores 825-RP, which provided models for TRNSYS, which had numerical problems, and HVACSIM+, which worked well, though is noted in passing in Relevance and Benefits) and is out of date (ignores recent work based on Modelica, which largely addresses the model development objectives of the RTAR - Modelica system models can be linked to Energy Plus and will form the basis of the HVAC modeling in a major new version of Energy Plus currently under development. However, there is still an important need for verification/validation - this would be a better focus for the RTAR. 10- feels like author was responsive to concerns from RAC; I have not seen this RTAR before (from my section)	
Research Need: Based on the background provided is the need for additional research clearly identified? If not, then the RTAR should be rejected.	13, 9, 6	9- There will be many flow network simulation models, which will be used for city level waterworks or for complicated industrial plants. Why cannot such flow network simulation models be coupled with building energy simulation models? 6 - Hydraulic simulation is a mature technology and used in design. It is hard to justify why this research is necessary. Integrating hydraulic simulation into BPS tools should be done by software developers. It is not a research item. 11 - Simulation methods and tools are now available and model development has progressed to the point where the limitations of existing models need to be determined empirically. 10 - I'm concerned that the RTAR claims that more than 20% of office building energy is 'distribution', w/o separating air-side from water-side. In the US, I expect that water-side is low for most building; air distribution only), but important for chilled water systems. I could be wrong.	
Relevance and Benefits to ASHRAE: Evaluate whether relevance and benefits are clearly explained in terms of: a. Leading to innovations in the field of HVAC & Refrigeration b. Valuable addition to the missing information which will lead to new design guidelines and valuable modifications to handbooks and standards. Is this research topic appropriate for ASHRAE funding? If not, Reject.	13, 6	9 - It will be required for the precise energy simulation of buildings and it will be useful to ASHRAE's efforts towards zero energy buildings (ZEB). 6 - Based upon the description of RTAR, the value addition to ASHRAE should be limited. 10 - I'm concerned that the RTAR claims that more than 20% of office building energy is 'distribution', w/o separating air-side from water-side. In the US, I expect that water-side is low for most buildings (air distribution only), but important for chilled water systems. I could be wrong.	
IF	ABOVE THR	EE CRITERION ARE NOT <u>ALL</u> SATISFIED - MARK "REJECT" BELOW & CONTINUE REVIEW BELOW	
Other Criteria	Voted NO	Comments & Suggestions	
Project Objectives: Based on the background and need, evaluate whether the project objectives are: 1. Aligned with the need 2. Specific 3. Clear without ambiguity 4. Achievable If not, then appropriate feedback should be provided. Expected Approach and Budget: Is there an adequate		10: I'm not sure that the objectives are realistic; I wonder about (possibly non-linear?) pressure drop variations with size within a class . Consider variations within same kinds of valves, within "Ls" with inner radius ratio to fitting ID, etc.	
description of the approach in order for RAC to be able to evaluate the appropriateness of the budget? If not, then the RTAR should be returned for revision. Anticipated funding level and duration:	6	2 - The project description includes the literature review. It is quite strange as the Authors argue that there is a need for such a novel system and at the same time want to perform the literature review to examine whether it exists already. A contradiction. 6 - Budget seems excessive based upon the scope and project period (12 M). 10 - I'm not convinced that the budget is excessive, given the task of experimental validation.	
References: Are the references provided?		10: yes	
Desision Ontions	Initial	Einst Annound Conditions	
ACCEPT AS-IS ACCEPT W/COMMENTS		7 - Work statement should provide details on expected technical approach. WS should also provide plans for technology transfer. How the algorithms will be made available to ASHRAE members for implementation. 9 - Flow network simulation models used for industrial plants should be referenced. And state how such a simulation model will be combined with building simulation models. Coupling the building simulation model willor model will be combined with building simulation models why. 2 - 4 members of the committee did not vole. RTAR needs modification and re-vote. 11 - Refocus research effort on model validation. 10 - Cover page marked that 4 members not present or did not return ballot. Was this a mail-ballot? Coordinate with other TC's, especially TC 1.4 and TC 4.7 as suggested by RAC in respose to earlier RTAR submission.	
REJECT			

ACCEPT Vote - Topic is ready for development into a work statement (WS). ACCEPT W/COMMENTS Vote - Minor Revision Required - RL can approve RTAR for development into WS without going back to RAC once TC satisfies RAC's approval condition(s) REJECT Vote - Topic is not acceptable for the ASHRAE Research Program

Research Topic Acceptance Request Cover Sheet			Date:
(Please Check to Insure the Following Information is in the Work Statement) A. Title B. Applicability to ASHRAE Research Strategic Plan C. Application of the Results D. State-of-the-Art (background)			Title:
E. Advancement to State-of-the-Art F. Justification and Value to ASHRAE G. Objective H. Estimated Duration I. References			RTAR# (To be assigned by MORTS)
			Results of this Project will affect the following Handbook Chapters, Special Publications, etc.:
Responsible TC/TG:			Date of Vote:
	For Against Abstaining Absent or not returning Ballot Total Voting Members	·	Co-sponsoring TC/TG/MTG/SSPCs (give vote and date):
RTAR Lead Author: Expected Work Statement Lead Author:			Potential Co-funders (organization, contact person information):
Research Classification: Basic/Applied Resear Advanced Concepts Technology Transfer	rch		
Has an electronic copy bee Has the Research Liaison r	en furnished to the MORTS? reviewed the RTAR?		Yes No

\* Reasons for negative vote(s) and abstentions

# **DRAFT RTAR Template**

Title: \_\_\_\_\_

#### Summary

Describe in summary form the proposed research topic, including what is proposed, why this research is important, how it will be conducted, and why ASHRAE should fund it (50 words maximum)

#### Background

Provide the state of the art with key references (at the end of this document) substantiating it (300 words maximum)

### **Research Need**

Use the state of the art described above as a basis to specify the need for the proposed effort (250 words maximum)

# **Project Objectives**

Based on the identified research need(s), specify the objectives of the solicited effort that will address all or part of these needs (150 words maximum)

# **Expected Approach**

Describe in a manner that may be used for assessment of project viability, cost, and duration, the approach that is expected to achieve the proposed objectives (200 words maximum).

Check all that apply: Lab testing (), Computations (), Surveys (), Field tests (), Analyses and modeling (), Validation efforts (), Other (specify) ()

# **Relevance and Benefits to ASHRAE**

Describe why this effort is of specific interest to ASHRAE, its impact, and how it will benefit ASHRAE and the society. How does it align with ASHRAE Strategic Plans and Initiatives? How does it advance the state of the art in this area in general? Are there other stakeholders that should be approached to obtain relevant information or co-funding? (350 words maximum)

Anticipated Funding Level and Duration

Funding Amount Range: \$\_\_\_\_\_

Duration in Months: \_\_\_\_\_

# References

List the key references cited in this RTAR

Project ID	1736
Project Title	A novel approach for modeling of hydronic systems in Building Performance Simulation (BPS) tools
Sponsoring TC	TC 6.1, Hydronic & Steam Equipment & Systems
Submission History	S150,000/12M RTAR1st Stubmission
Classification: Research or Technology Transfer	Basic/Applied Research
Check List Criteria	VOTED NO Comments & Suggestions
Is there a well-established need? The RTAR should include some level of literature review that documents the importance/magnitude of a problem. If not, then the RTAR should be returned for revision.	#10 - Need is not well established. It is not well stated the inaccuracies due to current approach in the calculations and resulting impact on the prediction of energy performance. #14-Maybe, but the case isn't clearly presented here. #7 - Would like to know how this study would improve what is currently available in the market. How inaccurate are the commercially available software packages? #2-Improvement in the simulation of the hydronic systems will provide better results and better understanding of the effect of different designs on a buildings performance. #13 - Component models and a control system evaluation framework were developed in 825-RP. There is an existing RTAR from TC4.7 and TC1.4 that addresses substantial parts of the proposed work. (Need for TC coordination!), DOE is developing an implementation of this approach using Modelica for incorporation in Energy Plus for supervisory control. There is a need for a controls design tool shell for a Modelica/Energy Plus implementation. #6 - the definition and performance requirements of 'a novel approach' seem vague. The contractor could define based on his/her own understanding or preference, leading to the quality of research potentially difficult to evaluate.
TC 6.1 Research Subcommittee Response	<b>#10,14</b> The RTAR has been re-written to explain that there is need for a more accurate method to model hydronic systems during their ever-changing variable flow modes. Popular software (EnergyPlus and TRYNSYS) only address flow at predetermined rates of their associated pump at design conditions. This RTAR project is intended to develop a new pressure governing approach to produce a more accurate simulation. This is considered a "Novel Approach" to modeling hydronic systems. More details provided in the "Background" and "Research Need" sections of the RTAR <b>#7</b> In the existing building performance simulation tools, the flow rate of the branches is also determined as predefined fraction of the main loop. However, in the real world, the flow rate of the branches is also determined as a predefined fraction of the develop a pressure governing approach for producers. This is postems. This proposal is intended to develop a pressure governing approach of hydronic systems. This has been further described in the "Beckground" sections of the proposal is and better understanding of the effect of different designs on buildings performance and balancing of the hydronic systems will provide better results and better understanding of the effect of different designs on buildings performance including energy performance and balancing of the hydronic systems at the early stage of design. #13 TC 6.1 will seek co-sponsorship of this RTAR from TC 1.4, TC 4.7, and TC 7.9. #8 Developing a simulation algorithm that is able to model the system in a pressure governing approach is the key point of the proposal. Such an algorithm will be able to measure the performance of systems including performance including endormance and balancing of the hydronic systems and perfect the most challenging and often ignored phenomena in hydronic systems including starving, overflow and lack of controllability.
Is this appropriate for ASHRAE funding? If not, then the RTAR should be rejected. Examples of projects that are not appropriate for ASHRAE funding would include: 1) research that is more appropriately performed by industry, 2) topics outside the scope of ASHRAE activities.	#8- The project requires contractor to integrate the hydraulic model into an existing energy simulation tool such as Energy Plus or TRNSYS. This may be difficult for contractors who does not have prior experience developing those BPS tools.
TC 6.1 Research Subcommittee Response	#8 EnergyPlus and TRYNSYS are two of the most applicable and widely used tools in building mechanical services modeling. Therefore, this RTAR is intended to be implemented into those platforms. After developing the new algorithm for hydronic systems modeling and successful implementation of the algorithm, it could also be adopted by other programs such as eQuest.
Is there an adequate description of the approach in order for RAC to be able to evaluate the appropriateness of the budget? If not, then the RTAR should be returned for revision.	#10 - There are several flow network analysis software both in public and commercial domain which can perform this analysis. It should be noted the key component in these analyses is pressure loss data of each element in the flow network. #7 - Would like to see more elaboration on how this study would vary from current methodology. #13 - A bigger challenge than developing component models is the development of a platform with robust numeric's and an effective user interface. #8- The objectives need to be clear. Otherwise the level of efforts in both modeling and experimental validation are difficult to evaluate.
TC 6.1 Research Subcommittee Response	The RTAR has been re-written ("Expected Approach" and "Relevance and Benefits to ASHRAE") to provide more clarity in explaining the need for this research project. #10 The existing flow network analysis tools are stand alone and are not capable of conducting the building performance simulation and detailed pressure governing hydronic system modeling simultaneously. In other words, the integration of an advance pressure governing hydronic system modeling to unique attributes of this proposal. Apart from considering the protonic system modeling and building performance simulation is one of the unique attributes of this proposal. Apart from considering the protonic system considering the variable bilding performance simulation is one of the unique attributes of this proposal. Apart from considering the variable theydronic system considering the variable in the system (which is essential) the algorithm would be able to assess the actual operation point of the hydronic system considering the variable in the pressure loss of the components as well as the performance curve of the variable flow hydronic system. <b>#7</b> The difference between the current methodology and the proposed approach is described in more detail in the "research Need" and "Background" sections of the proposal. <b>#13</b> The evelopment of a platform with robust numeric's and an effective user interface is one of the important points that is considered in the proposal. For instance TRNSV's and Energ/Plus are capable of providing such an interface mainly due to the component base nature of these platforms. <b>#1</b> The objective's section of the proposed RTAR. In a very brief description, this proposal is interded to provide a platform and an accurate algorithm for the simulation of hydronic systems and predict the most challenging and often ignored phenomena such as starving, overflow and lack of controllability in the system.
Is the budget reasonable for the project scope? If not, then RTAR could be returned for revision or conditionally accepted with a note that the budget should be revised for the WS.	#14 - Seems like a very odd budget, is this an RTAR estimate or a price quote? #7 - Hydronic component manufacturers should provide co-funding. #13 - Already done for TRNSYS; implementation in Energy Plus would require > \$100k. #8 - The budget should be an estimate and leave to the contractor to give an accurate number. #4 -As a non-specialist, I think there might be some key missing links. The RTAR refers to issues of non-linearity, particularly in valves (of different types), but I just don't know if there is senough documentation to guide designers of different types of variable flow hydronic systems about specifications they need for their systems. Tied to this is another area where I'm ignorant sort of an "extended products" question. Should engineers' design tools include modules that assure that branch controls are optimizing (valves and pumping)? How does this ite to some of the newer VSD cartridge pumps for zone control, and how they do or don't interact with boilers (or other heat/cool sources)? I'd like to how how this RTAR fits into the TC's overall research plan, which I think should drive toward making good, robust designs easier for the consultant.
TC 6.1 Research Subcommittee Response	#14 and 8 The revised budget provided is an approximation based on current perceived costs related to this type of project. It is the Author's best estimate. #13 The hydronic system modeling in Building Performance Simulation (BPS) tools such as TRNSYS and EnergyPlus are not designed based on a pressure governing simulation approach (EnergyPlus, 2011; Klein et al., 2009). In TRNSYS, all the developed components simulate a hydronic system based on either a predefined operating point of the hydronic systems or the intersection of the predefined performance curves of the hydronic system and circulation pump. However, in reality these performance curves are changing with any single alteration of the opening fraction of control valves in variable flow hydronic systems. This RTAR is going to implement the algorithm in TRNSYS and proposed the approach for EnergyPlus. #4 Some manufacturers of hydronic systems components provide very detailed specification of their products (due to concern about commercialism are not mentioning here). But, the point is wisely raised and of course it is not the case for all manufacturers. However, providing this precise algorithm and its integration into building simulation lools provide a platform for better design in which the system as a whole and branches can be balanced at the early stages of the design and the likelihood of starving, overflow and lack of control lability could be assessed. In case that designers are facing the lack of detailed specification required for the modeling (for example control valve performance curves), assuming the specification of similar available products and simulation of the hydronic system as a pressure governing system and ignoring the ever-changing nature of hydronic system in variable flow system. References: <ul> <li>EnergyPlus (2011). Engineering reference: The reference to EnergyPlus calculations. Berkeley: Lawrence Berkeley National Laboratory.</li> <li>Klein, S. A., Beckman, W. A., Mitchell, J. W., Duffle, J. A., Duffle, N. A.</li></ul>

Have the proper administrative procedures been followed? This includes recording of the TC vote, coordination with other TCs, proper citing of the Research Strategic Plan, etc. If not, then the RTAR could be returned for revision or possibly conditionally accepted based on adequately resolving these issues.		#4 - seems ok
Decision Options	Initial Decision	ApprovalConditions
ACCEPT		#7 - Project needs more justification before acceptance. #13 - Coordinate with other TC's, esp. TC1.4 and TC4.7. #4 - I need a briefing to help me understand why this is the critical path, why my concerns are unfounded, and how this fits on the path to better designs and implementation. I'd also like to see more emphasis on tech transfer to the working designers, for example with an ASHRAE Journal article (pitfalls and how to avoid them?)
TC 6.1 Research Subcommittee Response		#7 The RTAR has been re-written to explain that there is need for a more accurate method to model hydronic systems. Justification for the proposal is now provided in the "research need" of the RTAR. #13 TC 6.1 will seek co-sponsorship of this RTAR from TC 1.4, TC 4.7, and TC 7.9. #4 TC 6.1 will ensure that the Author responds to any additional concerns of RAC's committee. It is anticipated that the research results will be introduced to ASHRAE via a conference presentation and/or Journal article.
COND. ACCEPT		
RETURN		
REJECT		

ACCEPT Vote - Topic is ready for development into a work statement (WS). COND. ACCEPT Vote - Minor Revision Required - RL can approve RTAR for development into WS without going back to RAC once TC satisfies RAC's approval condition(s) RETURN Vote - Topic is probably acceptable for ASHRAE research, but RTAR is not quite ready. REJECT Vote - Topic is not acceptable for the ASHRAE Research Program